NONLOCALITY AND THE KOCHEN-SPECKER PARADOX

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EXTENSION OF NOTATION TO TWO SEPARATED SYSTEMS

$$\left[Q \otimes I\right]^{\phi}_{\{\langle A,B\rangle\}} \qquad (D,E)$$

where $\langle A,B\rangle$ is the observable on the joint system associated with the operator

$$\hat{O} = \sum_{i,j} F(\alpha_i, \beta_j)\, \hat{P}_i \otimes \hat{P}'_j$$

where $\hat{A} = \sum_i \alpha_i \hat{P}_i$

$\hat{B} = \sum_i \beta_i \hat{P}'_i$

and $F: \mathbb{R}^2 \to \mathbb{R}$ is 1:1 map.

LOCALITY PRINCIPLES

$\forall Q, A, B, C, D, E$, where $Q = h(A)$ and $A, B, C, D \& E$ are all maximal

OLOC:

$$[Q \otimes I]^{\phi}_{\{\langle A,B\rangle\}}(D,E) = [Q \otimes I]^{\phi}_{\{\langle A,C\rangle\}}(D,E)$$

ELOC:

$$[Q \otimes I]^{\phi}_{\{\langle A,B\rangle\}}(D,E) = [Q \otimes I]^{\phi}_{\{\langle A,B\rangle\}}(D,C)$$

THE COMEASURABLE VALUE RULE (CVR)

We derive CVR from VR and FUNC*

CVR: If $\hat{Q}_1$ and $\hat{Q}_2$ commute and $\hat{R}$ is a maximal operator s.t. $\hat{Q}_1 = f(\hat{R})$, $\hat{Q}_2 = g(\hat{R})$

Then $P^{\phi}_{Q_1,Q_2}(\lambda,\mu) = 0 \Rightarrow$

$$[Q_1]^{\phi}_{\{R\}}(R) \neq \lambda$$

or $$[Q_2]^{\phi}_{\{R\}}(R) \neq \mu$$

CVR FOR SEPARATED SYSTEMS

If $\hat{Q} = h(\hat{A})$, $\hat{Q}' = k(\hat{B})$

where A, B are maximal

Then

$$P^{\phi}_{Q\otimes I,\, I\otimes Q'}(x,y) = 0 \Rightarrow$$

$$[Q\otimes I]^{\phi}_{\{\langle A,B\rangle\}}(A,B) \neq x$$

or

$$[I\otimes Q']^{\phi}_{\{\langle A,B\rangle\}}(A,B) \neq y$$

INCOMPATIBILITY OF CVR AND LOCALITY

Consider correlated state of 2 separated systems

$$\Psi = \sum_m c_m |a_m\rangle_A \otimes |b_m\rangle_B$$

Consider non maximal operator $\vec{Q}$ s.t. $\vec{Q} = f(\hat{A}) = g(\hat{A}')$ where $[\hat{A}, \hat{A}'] \neq 0$

Then

$$[A \otimes I]^{\Psi}_{\{\langle A,B\rangle\}}(A,B) = a_m$$

$$\Rightarrow [I \otimes B]^{\Psi}_{\{\langle A,B\rangle\}}(A,B) = b_m .$$

Also

$$[I \otimes B]^{\psi}_{\{\langle A', B\rangle\}}(A', B) = \sigma_m$$

$$\Rightarrow [f(A \underset{Q}{\otimes} I)]^{\psi}_{\{\langle A', B\rangle\}}(A', B) = f(a_m)$$

Now apply ELOC & OLOC to equate

$$[I \otimes B]^{\psi}_{\{\langle A, B\rangle\}}(A, B) = [I \otimes B]^{\psi}_{\{\langle A', B\rangle\}}(A', B)$$

Hence we obtain FUNC**:

$$[f(A \otimes I)]^{\psi}_{\{\langle A', B\rangle\}}(A', B)$$

$$= f\left([A \otimes I]^{\psi}_{\{\langle A, B\rangle\}}(A, B)\right)$$

INTERACTION OF PHYSICS AND PHILOSOPHY

Either 1) Physics should be changed in the light of philosophical preconceptions

or 2) Philosophical ideas should be modified in the light of new theories in physics

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